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Innovation in Canadian Manufacturing: National Estimates

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Innovation in Canadian Manufacturing: National Estimates

Survey of Innovation

1999

Susan Schaan and Frances Anderson

Science, Innovation and Electronic Information Division

June 2001

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This working paper is the result of a collaborative project between the Science, Innovation and Electronic Information Division, Statistics Canada, Industry Canada, Natural Resources Canada and the National Research Council of Canada

Working Papers

The Working Papers publish research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada nor, in this case, the views of Industry Canada, Natural Resources Canada or the National Research Council of Canada.

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The Science and Innovation Information Program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors**: are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities**: include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages**: are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes**: are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts**: are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical Information System,** Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193.

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Preface

Innovation is vital to economic growth and development. It is through innovation that new products are introduced to the market, new production processes are developed and introduced and organizational changes are made.

The Survey of Innovation 1999 surveyed manufacturing and was the first innovation survey of selected natural resource industries. Statistics Canada has conducted several surveys of innovation since 1993 to better understand innovation in Canada. The 1993 Survey of Innovation and Advanced Technology surveyed manufacturing firms. The Survey of Innovation, 1996 surveyed the communications, financial services and technical business services industries. The 1999 Survey of Innovation, Advanced Technologies and Practices in the Construction and Related Industries was the first survey of advanced technologies and practices in the construction sector. The 1999 Survey of Innovation was an opportunity to supplement the study of Innovation, Advanced Technologies and Practices in the Construction and Related Industries and to examine the relationship between construction and manufacturing. To explore this relationship, questions were added to the 1999 Survey of Innovation to explore manufacturing and natural resource suppliers to the construction industry. A question to explore the linkage between manufacturing and natural resource firms was also included.

The information compiled from the Survey of Innovation can be used by firms for market analysis, by trade associations to study performance and other characteristics of their industries, and by government to develop national and regional economic policies.

This is the first in a series of working papers that will examine the results from the Survey of Innovation 1999. This first paper examines innovation in manufacturing. Subsequent papers will include an examination of innovation in manufacturing at the provincial level, innovation in selected natural resource industries at the national level and at the provincial level. These working papers will be followed by research papers.

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Highlights

The Survey

Statistics Canada conducted the Survey of Innovation during the fall of 1999. Design of the questionnaire was done by the Science, Innovation and Electronic Information Division of Statistics Canada in collaboration with Industry Canada, Natural Resources Canada and the Institute for Research in Construction of the National Research Council of Canada, with the participation of the Canadian Construction Research Board.

Percentage of Innovative Manufacturing Firms

Results from the Survey of Innovation 1999 show that 80% of Canadian manufacturing firms were innovative during the period 1997-1999.

Novelty of Innovation

For the 88% of innovative manufacturing firms which provided a description of the most important innovation, 12% indicated that it was a world first innovation. One third (32%) indicated that it was a first in Canada. One fifth (20%) indicated that it was a first in Canada but not a world first.

Sources of Information for Innovation

The three most important internal sources of information needed for suggesting or contribution to the development of new or significantly improved products or processes for innovative manufacturing firms during the period 1997-1999 were management staff (74%), production staff (70%) and marketing staff (64%). The three most important external sources were trade fairs and exhibitions (66%), suppliers of equipment, material and components (63%) and clients (63%).

Activities Linked to Innovation

The majority (86%) of innovative manufacturers have engaged in the acquisition of machinery, equipment or other technology linked to new or significantly improved products or production/manufacturing processes during the period 1997-1999.

Research and Development

Over two thirds (68%) of innovative firms in manufacturing indicated that they undertook R&D activities during the period 1997-1999.

Cooperative and Collaborative Arrangements

During the period 1997-1999, 33% of innovative manufacturing firms were involved in cooperative and collaborative arrangements to develop new or significantly improved products or processes.

Intellectual Property

Almost three-quarters (73%) of the innovative firms in manufacturing used some method to protect their intellectual property during the period 1997-1999.

Objectives of Innovation

The three objectives of innovation during the period 1997-1999 most commonly indicated as being important were to improve product quality (83%), to increase production capacity (75%), and to extend product range (72%).

Problems and Obstacles Faced by Innovative Manufacturing Firms

Ninety-one percent (91%) of innovative manufacturing firms faced problems or obstacles which slowed down or caused problems when they developed new or significantly improved products or introduced new or significantly improved processes during the period 1997-1999. The most widespread obstacle was the inability to devote staff to projects on an on-going basis because of production requirements (56%). This was followed by the high cost of development (53%) and lack of skilled personnel (37%).

Government Support Programs

Over half (58%) of innovative manufacturing firms indicated that they used either a federal or provincial government support program during the period 1997-1999. The most used program was research and development (R&D) tax credits (40%) followed by government support for training (22%).

Impact of Innovation

Approximately the same percentage of product innovators in manufacturing had sales from new products (94%) or significantly improved products (91%).

When innovative manufacturing firms were asked to indicate their agreement to a list of important impacts of the new and significantly improved products and processes seventy-seven percent (77%) agreed that it allowed the firm to keep up with competitors.

Human Resources

Over half (58%) of the innovative manufacturing firms indicated that their total number of employees had increased during the period 1997-1999.

Acknowledgements

The Survey of Innovation 1999 was a collaborative project with contributions from Industry Canada, Natural Resources Canada and the Institute for Research in Construction of the National Research Council of Canada.

The testing of the questionnaire was done by Statistics Canada's Questionnaire Design Resource Centre and was carried out by Allan Gower, Marie-Josée Williams and Anna Paletta.

The questionnaire mail-out and collection/data capture was carried out by Survey Operations Division, under the direction of Lloyd Nieman and Linda Balloch.

The Business Survey Methods Division was responsible for the methodology of the survey. In particular, the authors would like to thank Yves Morin and Nicolas Lavigne.

Within the Science, Innovation and Electronic Information Division special thanks goes to Brian Nemes and Brenda Hutchinson for their contributions to the survey. Additional thanks are extended to Claire Simard, Heather Prieur and Lynda Auger for their work on statistical tables and to Claire Racine-Lebel for her assistance in preparing the working paper for publication.

Finally, the authors would like to thank the 5455 manufacturing firms who completed the questionnaire. Without their cooperation and goodwill, this working paper would not exist.

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Introduction

This working paper is the first in a series of studies that results from a collaborative project between the Science, Innovation and Electronic Information Division of Statistics Canada, Industry Canada, Natural Resources Canada and the Institute for Research in Construction of the National Research Council of Canada. The objective of the project is to provide pertinent information on innovation and related activities with an ultimate view to developing policies and programs. This paper will examine the characteristics of innovative manufacturing firms in Canada based on results from the Survey of Innovation 1999.

What is innovation?

The Oslo Manual (OECD/Eurostat, 1997) outlines proposed guidelines for collecting and interpreting innovation data. This manual identifies two types of innovation – product and process. In the case of product innovation, the product must have been introduced to the market. A process innovation must have been used within the production process. An innovative firm is one that has implemented a new or significantly improved product or process during the last three years.

The term product includes both goods and services as innovation outputs. Product innovations can be broken down into new or significantly improved. A new product is one that is new to the firm, whose characteristics or intended uses differ significantly from those products previously produced by the firm. A significantly improved product is an existing product whose performance has been significantly enhanced or upgraded. A complex product consisting of a number of components or integrated subsystems may be improved by partial changes to one of the components or subsystems. Changes to a firm's existing products which are purely aesthetic or which only involve minor modifications are not considered to be innovations.

New production/manufacturing processes are those which are new to the firm. They involve the introduction of new production/manufacturing methods, procedures, systems, machinery or equipment into the firm. These must differ significantly from the firm's previous processes. Significantly improved production/manufacturing processes involve significant changes to existing processes which may be intended to produce new or significantly improved products or processes. Minor or routine changes to processes are not considered to be innovations.

Innovations may be oriented towards product, process or both product and process. By definition, an innovation must necessarily be a firm first, however, the degree of novelty varies. An innovation may involve a major breakthrough discovery that is a first in the world or it can be an innovation that is a first in Canada.

How does innovation take place?

Innovation and innovative activities may be carried out within the firm or may involve the acquisition of goods, services or knowledge from outside sources. The process of innovation can be assisted by a variety of sources of information including internal sources (within the firm), external market sources, educational and research institutions, and generally available information. Collaborations are one means by which innovation can occur through joint efforts from both inside and outside the firm.

There are numerous sources of information that can play a role in suggesting or contributing to innovation. Within a firm, R&D staff, marketing staff, production staff and management staff are all potential sources. Interactions with related firms in the corporate group (e.g. parent or subsidiary), suppliers of equipment, material and components, clients, consultancy firms, universities and colleges, federal or provincial agencies and research laboratories, and even clients can be an external source of information. Trade fairs and exhibitions, the Internet or computer based information networks, professional conferences, meetings and publications are all sources of information that are generally available to a firm.

Innovative firms can undertake a variety of activities linked to offering or introducing new or significantly improved products or processes. These include R&D, the acquisition of technology, or the acquisition of machinery and equipment with improved technological performance connected to firm innovation, activities in the preparations for production such as industrial engineering and industrial design, tooling up and production start-up and training linked to innovation.

Cooperative and collaborative arrangements involve the active participation in joint projects between a firm and other firms or organizations for the purpose of innovation. Pure contracting-out work, where there is no active participation, is not regarded as collaboration or cooperation. The reasons for these arrangements can be related to financial considerations (sharing costs, spreading risk), access to knowledge (R&D, critical expertise), prototype development, scaling-up production processes, accessing new markets and accessing new distribution channels.

An innovative firm can take steps to protect the intellectual property on which its innovations are based. Patents, trademarks, copyrights, confidentiality agreements or trade secrets are some of the methods that can be used by a firm to protect intellectual property.

Why do firms innovate?

The objectives of innovation can be related to productivity, product or some other motivation. The reduction of labour costs, increase in production capacity, reduction of production time and improvements to production flexibility are all productivity motivations. The extension of product range, improvement to product quality, increasing the speed of delivering products to the market and the replacement of products that are

being phased out are some objectives related to the product. Other objectives of innovation include the reduction of materials consumption reduction of environmental damage, reduction of energy consumption, and to deal with or to respond to new government regulations.

What are the factors affecting innovation?

The identification of obstacles to innovation is significant to policy development since many government measures are an attempt to overcome these. Various aspects of public policy can be examined through and examination of a firm's perception of obstacles to innovation. Two key areas are dealt within this working paper - obstacles in general and government support programs.

There are many possible factors that can slow down or cause problems for firms when they innovate. High costs, the inability to devote staff to innovation projects on an on-going bases because of production requirements, or the inability to qualify for government assistance programs or R&D tax credits are a few. A lack of one or more of the following inputs to innovation can also present obstacles: skilled personnel, financing, marketing capability, information on relevant technology, required external technical support services, access to expertise in universities and/or government laboratories for assistance, cooperation with other firms, customer responsiveness to new products. Organizational rigidities within the firm can hinder innovation and government regulations can affect innovation capability.

Public policy can provide incentives for innovation. Government support programs include R&D tax credits, R&D grants, venture capital support, technology support and assistance, information or Internet services, and support for training. Failure to qualify for these programs can be an obstacle to innovation.

What is the result of innovation?

There are a variety of approaches to assessing the effect of innovation on a firm. The proportion of sales from new or significantly improved products in one measure of impact. Innovation can also impact to varying degrees on productivity, profitability, speed of supplying and/or delivering products, and the ability to adapt flexibly to different client demands. Other results of innovation can be an increase in domestic market share, increase in international market share, maintenance of profit margins, and keeping up with competitors. Finally, there can be an effect on human resources, whether the number of employees in a firm increases, decreases or remains the same.

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1. The Survey

Questionnaire development

The questionnaire was designed by the Science, Innovation and Electronic Information Division of Statistics Canada in collaboration with Industry Canada, the Institute for Research in Construction of the National Research Council of Canada and NRCan. Statistics Canada carried out interviews with individual firms in both official languages to ensure that the questions were well understood. Feedback from respondents was incorporated into the questionnaire design.

Characteristics and Coverage

The Survey of Innovation, was conducted by Statistics Canada from October to December 1999 with the first data release of preliminary estimates on January 31, 2000.

The questionnaire consists of thirteen sections with questions on competitive environment; firm success factors; new and significantly improved products and processes; sources of information; objectives; problems and obstacles; impact; cooperative and collaborative arrangements; most important new or significantly improved product or process; building and construction products; natural resource products; research and development, intellectual property and human resources; and government support programs.

Sampling Methodology

The target population was all firms in the manufacturing sectors (NAICS 31-33) (North American Industry Classification System) (Statistics Canada, 1998) or in selected natural resource industries (NAICS 1133, 212, 2211). This working paper will analyse the survey results for manufacturing industries. A subsequent working paper will analyse the results for the selected natural resource industries.

The population was based on a list of businesses compiled from respondents to existing production surveys conducted by Manufacturing, Construction and Energy Division (MCED) at Statistics Canada.

A total of 9,303 sample units were defined for the manufacturing industries from respondents to the Annual Survey of Manufactures. The sampling unit was neither at the enterprise nor the establishment level, rather, it was a grouping (or cluster) of establishments. Within each province for each enterprise, all establishments of the same NAICS 4-digit code were grouped to form one sampling unit or "provincial enterprise". To reduce response burden, provincial enterprises with revenues less than $250,000 were not included in the population and neither were those with less than 20 employees.

The sample was randomly drawn from the population of provincial enterprises that was stratified by province. Thirty-one industry categories for manufacturing based on NAICS codes were used. Details of the industry codes used are found in Annex 1.

A sample of 5944 provincial enterprises in manufacturing was drawn.

Data Collection

All sample units were contacted to determine the name and correct mailing address for respondent, the Chief Executive Officer (CEO) of the business or the person designated by the CEO. Questionnaires were mailed out with mail, telephone and fax follow ups carried out for non respondents.

Edit and Imputation

Validity and flow edits were built into the data capture system and were applied during data collection and data entry. Validity edits ensured that responses to particular questions fell within a limited range of possible values. Post collection consistency edits were applied to complete[1] questionnaires.

Imputation was used for non-response to non-mandatory questions on complete questionnaires. Donors were always from the same stratum as defined in Annex 1. No individual record was used as a donor more than four times for any given question.

Response and Non-response

The response rate for the Survey of Innovation 1999 was calculated as the total number of completed questionnaires as a percentage of the total active, in-scope survey sample. The overall response rate for the survey was 95%, for a total of 5455 completed questionnaires for manufacturing.

Sampling Error

Answers to the survey questions presented in this report are population estimates; that is, they represent the percentage of businesses in the population that exhibit a particular characteristic. The population estimates are generated through the application of sample weights when tabulations are generated.

As the sample drawn for this survey is but one of many possible samples that could have been drawn, there is a sampling error attributed to it. Standard errors are used to provide a guide as to the reliability of the results. All estimates presented in this paper have been evaluated for reliability and unless otherwise indicated, have standard errors less than or equal to 2.5%, that is to say that the estimates are "very good" (rating code A).

---

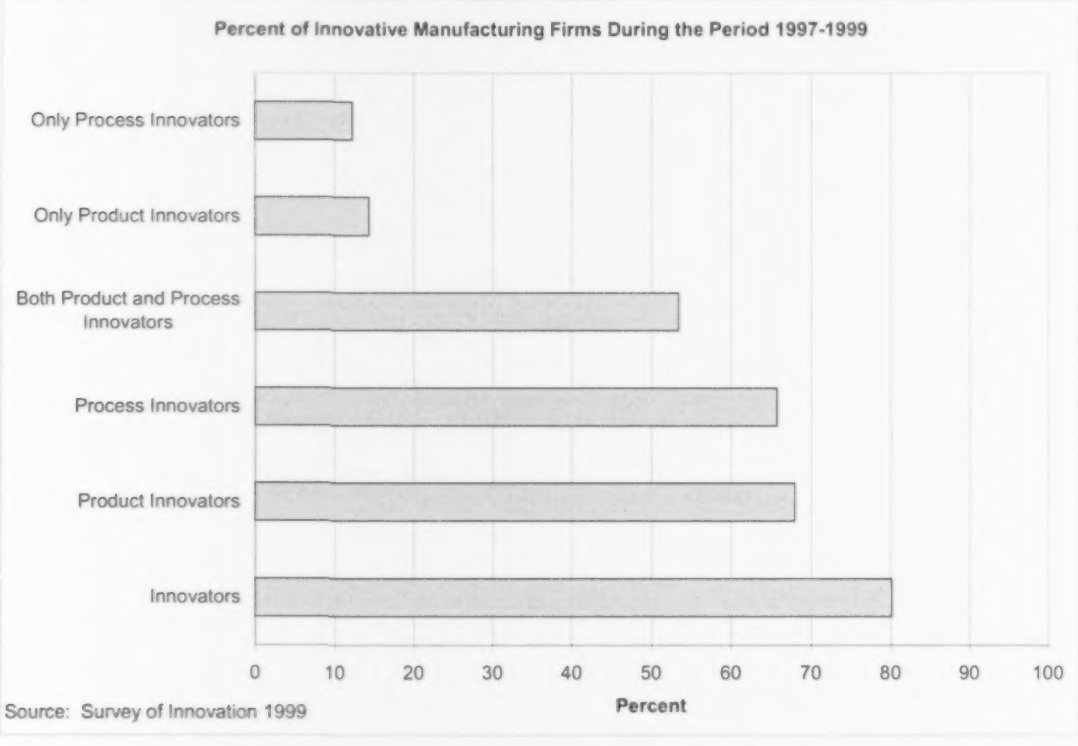
[1] Complete questionnaires are those which have responses to questions 3, 4, 5, 6, 12, 21, 22 and 23.

The reliability of the data has been assessed using the following convention:

Code	Rating	Standard Error
A	Very good	≤2.5%
B	Good	>2.5% and ≤7.5%
C	Good to poor- use with caution	>7.5 and ≤15%
D	Very poor- may not be acceptable	>15%

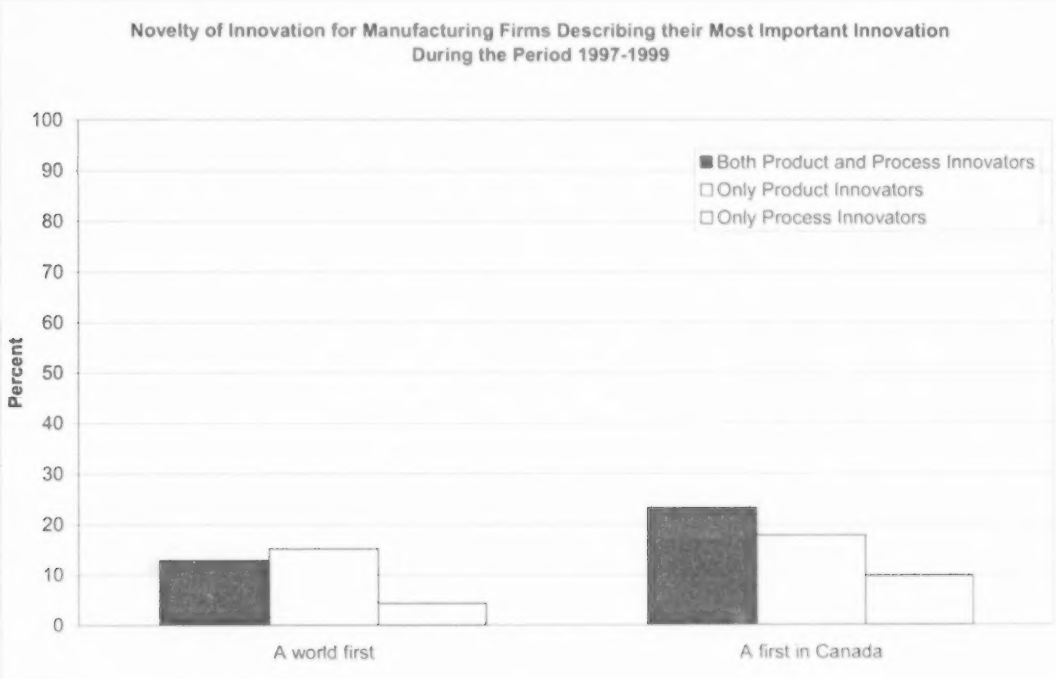
2. Percentage of Innovative Manufacturing Firms

Results from the Survey of Innovation 1999 showed that 80% of Canadian manufacturing firms were innovative, i.e. the firm offered a new or significantly improved product to its clients and/or introduced a new or significantly improved production/manufacturing process during the period 1997-1999. Approximately two thirds (68%) of Canadian manufacturing firms introduced product innovations and 66% introduced process innovations. More than half (54%) of Canadian manufacturing firms were both product and process innovators, 14% were only product innovators and 12% were only process innovators.



3. Novelty of Innovation

Respondents were asked to describe their most important innovation. For the 88% of innovation manufacturing firms who provided a description of the most important innovation, 12% indicated that it was a world first innovation. One fifth (20%) of these firms indicated that their most important innovation was a first in Canada.

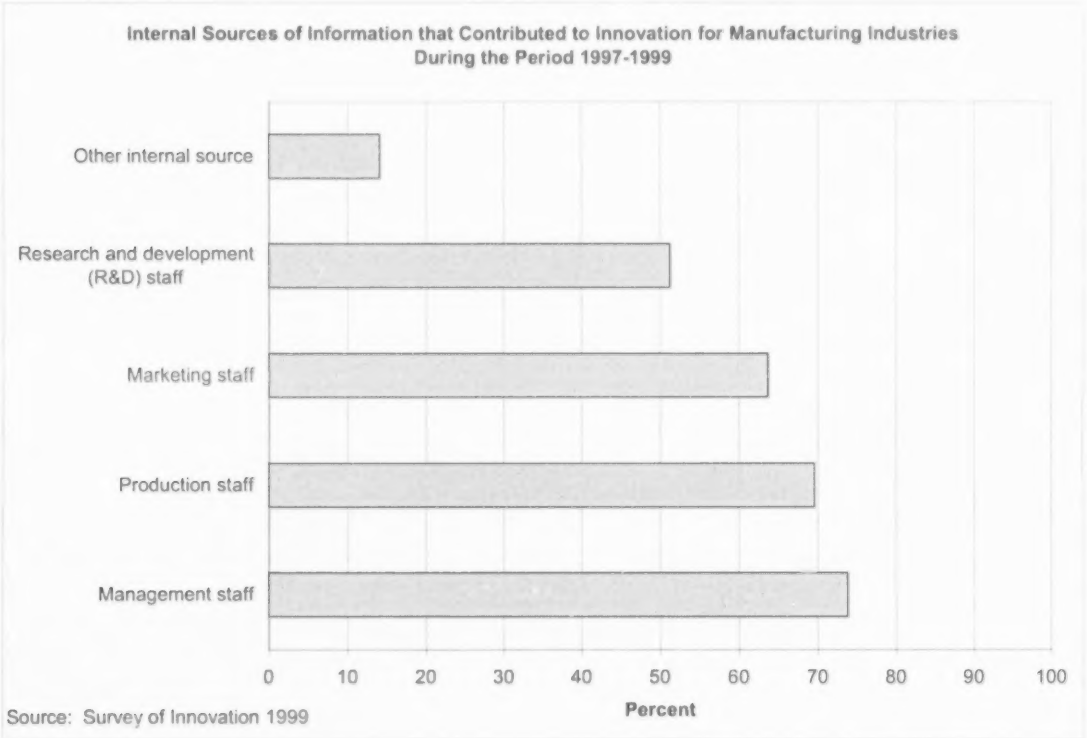


Source: Survey of Innovation 1999

Product only innovators had the highest percentage of world first innovations (15%). Both product and process innovators had the highest percentage of Canada first innovations (23%). Manufacturing industries that were only process innovators had consistently lower percentage of world first (43%) and Canada first (10%) innovations.

4. Sources of Information for Innovation

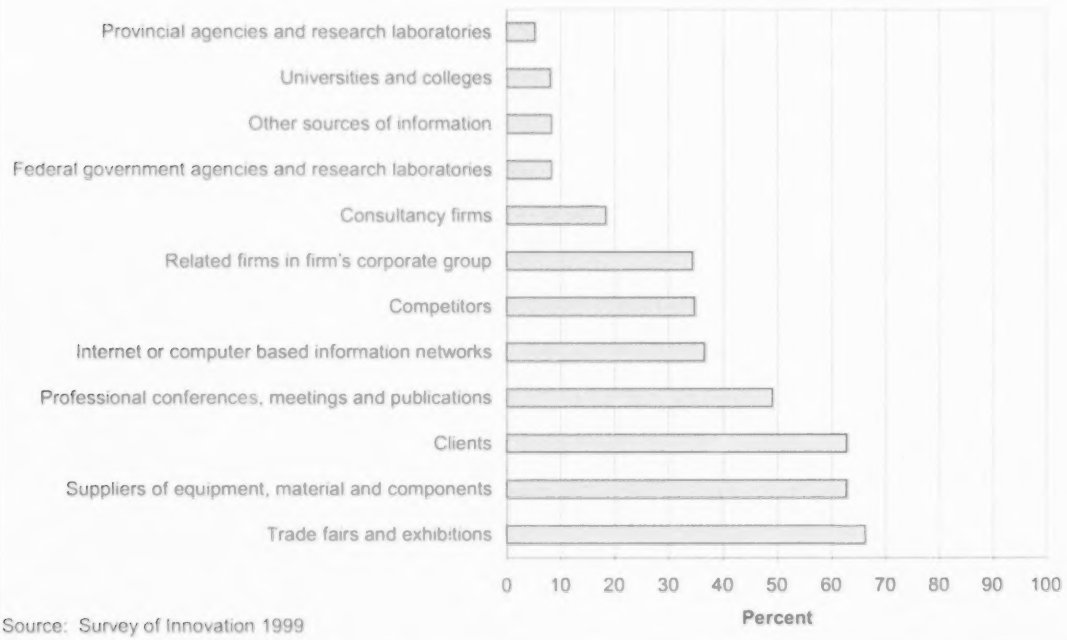
The four most important internal sources (internal to the firm) of information needed for suggesting or contributing to the development of new or significantly improved products or processes for innovative manufacturing firms were management staff (74%), production staff (70%) and marketing staff (64%) and research and development (R&D) staff (51%).



Source: Survey of Innovation 1999

The four most important external sources (external to the firm) of information needed for suggesting or contributing to the development of new or significantly improved products or process for innovative manufacturing firms were trade fairs and exhibitions (66%), suppliers of equipment, material and components (63%), clients (63%), and professional conferences, meetings and publications (49%).

External Sources of Information that Contributed to Innovation for Manufacturing Industries During the Period 1997-1999

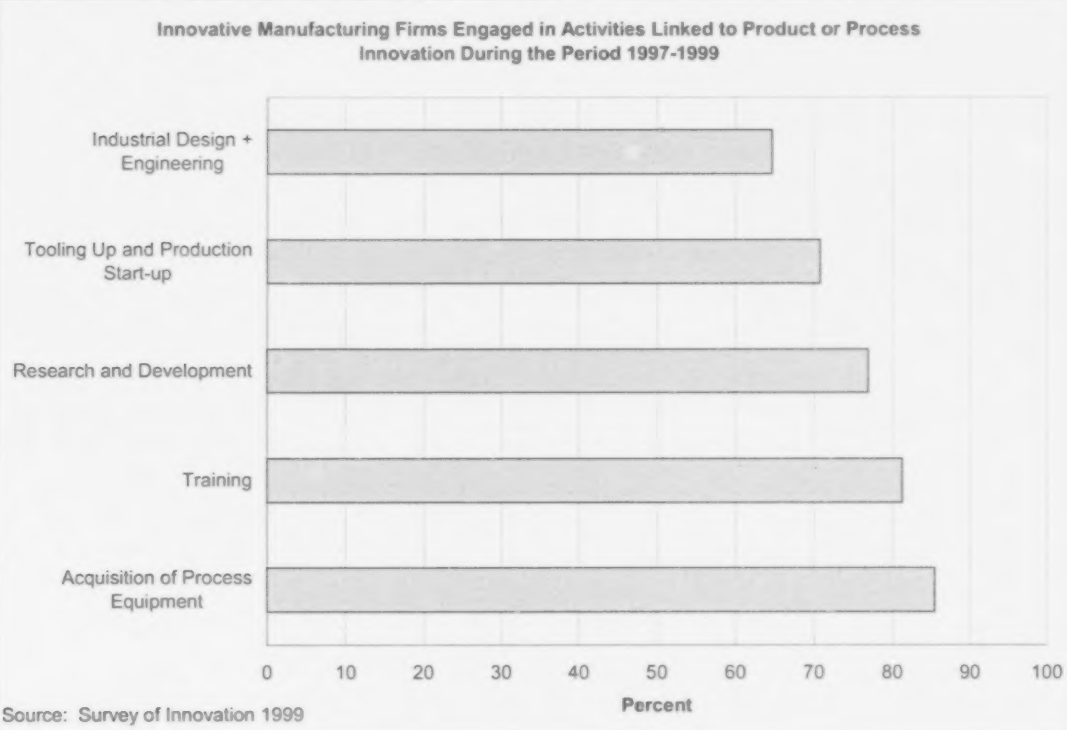

Provincial agencies and research laboratories
Universities and colleges
Other sources of information
Federal government agencies and research laboratories
Consultancy firms
Related firms in firm's corporate group
Competitors
Internet or computer based information networks
Professional conferences, meetings and publications
Clients
Suppliers of equipment, material and components
Trade fairs and exhibitions
0 10 20 30 40 50 60 70 80 90 100
Percent

Source: Survey of Innovation 1999

5. Activities Linked to Innovation

Firms indicated if they engaged in several activities that are linked to offering new or significantly improved products or to introducing new or significantly improved production/manufacturing processes during the period 1997-1999. Over 60% of all innovative manufacturing firms indicated that they engaged in at least one of five activities linked to product or process innovation.

More than 80% of innovative manufacturers indicated that they had engaged in the acquisition of machinery, equipment or other technology (86%) and training (81%) linked to new or significantly improved products or production/manufacturing processes. Over three-quarters (77%) of innovators in manufacturing indicated that they carried out research and development (R&D).

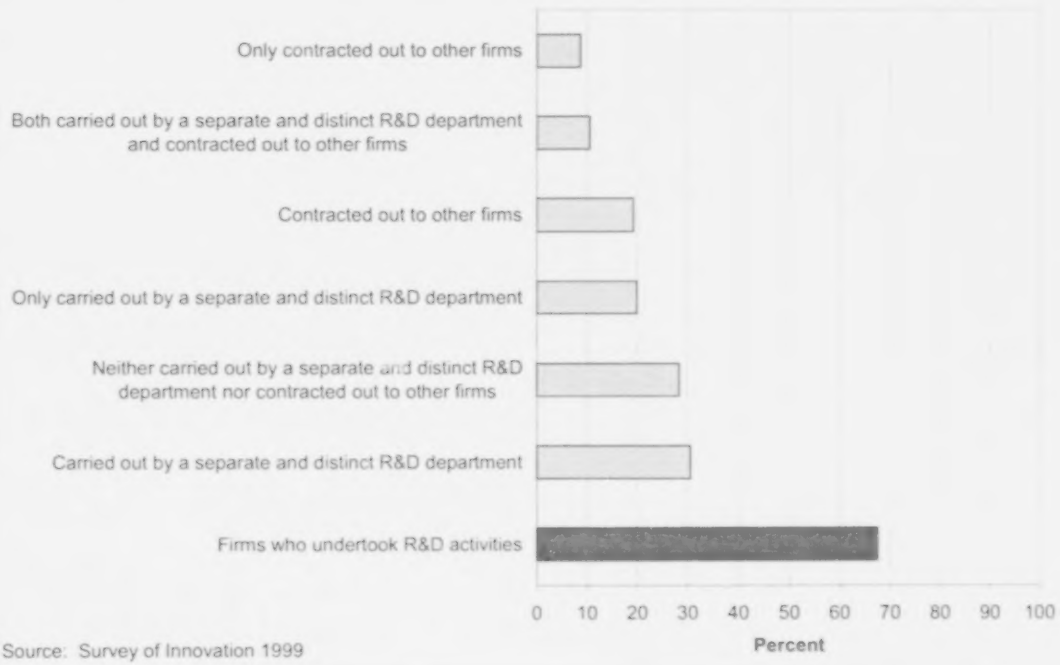


Source: Survey of Innovation 1999

6. Research and Development

Over two-thirds (68%) of innovative firms in manufacturing indicated that they undertook R&D activities[2]. Close to one third (31%) of innovative manufacturers indicated that these activities were carried out by a separate and distinct R&D department. Approximately one fifth of the innovative firms (19%) contracted R&D out to other firms. Ten percent (10%) of innovative manufacturing firms both carried out by a separate and distinct R&D department and contracted out to other firms. Over one quarter (28%) of innovative manufacturers carried out their R&D in some other manner.

Research and Development by Innovative Manufacturing Firms During the Period 1997-1999


Only contracted out to other firms
Both carried out by a separate and distinct R&D department and contracted out to other firms
Contracted out to other firms
Only carried out by a separate and distinct R&D department
Neither carried out by a separate and distinct R&D department nor contracted out to other firms
Carried out by a separate and distinct R&D department
Firms who undertook R&D activities
0 10 20 30 40 50 60 70 80 90 100
Percent

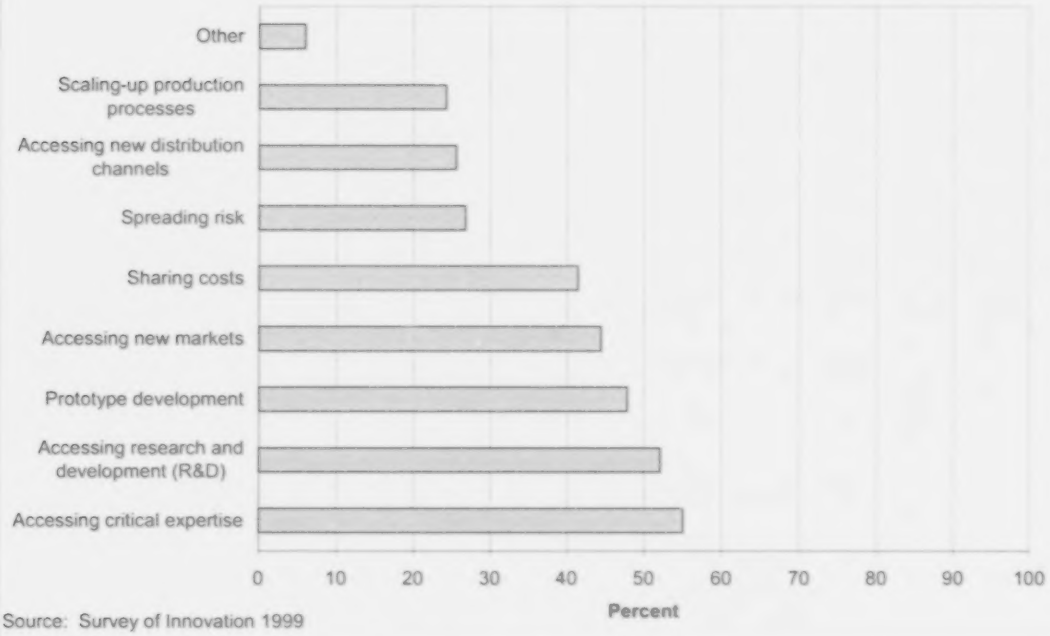
Source: Survey of Innovation 1999

[2]R&D results from the Survey of Innovation 1999 diverge from R&D results from the Survey of Research and Development in Canadian Industry (RDCI). For a discussion of this issue see Daood Hamdani, "Why Do the Surveys of Innovation and R&D Diverge?" in *Innovation Analysis Bulletin*, Vol. 2. No. 3 (September 2000), Statistics Canada Catalogue No. 88-003-XIE.

7. Cooperative and Collaborative Arrangements

During the period 1997-1999, one third (33%) of innovative manufacturing firms were involved in cooperative and collaborative arrangements to develop new or significantly improved products or processes. For these collaborators, the four most important reasons in determining the involvement in collaboration were accessing critical expertise (55%), accessing research and development (R&D) (52%), prototype development (48%), and accessing new markets (45%).

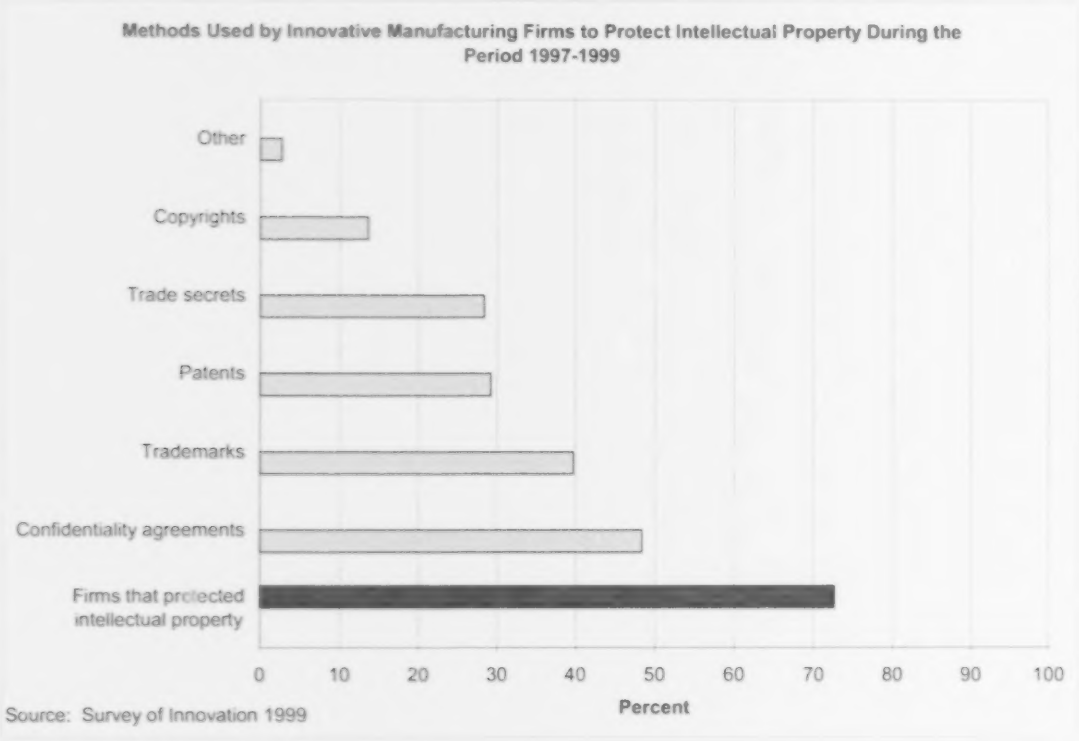
Reasons Reported by Innovative Manufacturing Firms for Entering into Cooperative and Collaborative Arrangements During the Period 1997-1999



Source: Survey of Innovation 1999

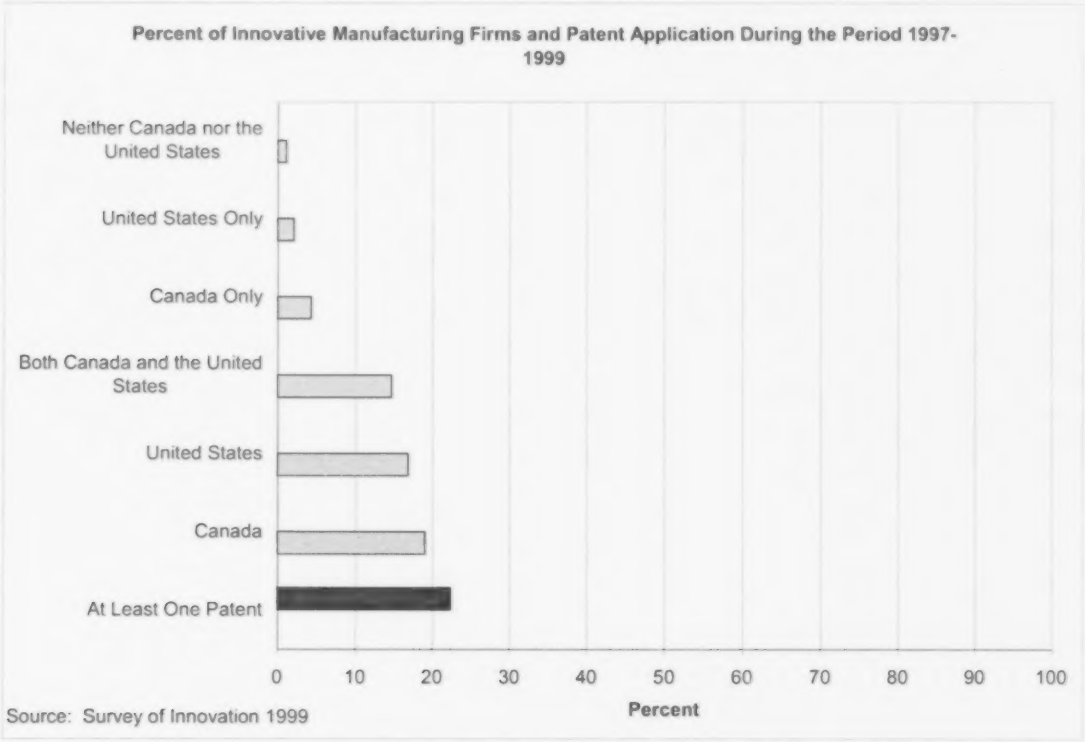
8. Intellectual property

Approximately three-quarters (73%) of the innovative firms in manufacturing used some method to protect their intellectual property. The preferred method chosen by almost half of the innovative manufacturing firms was confidentiality agreements (48%) followed by trademarks (40%), patents (30%), trade secrets (28%) and copyrights (14%).



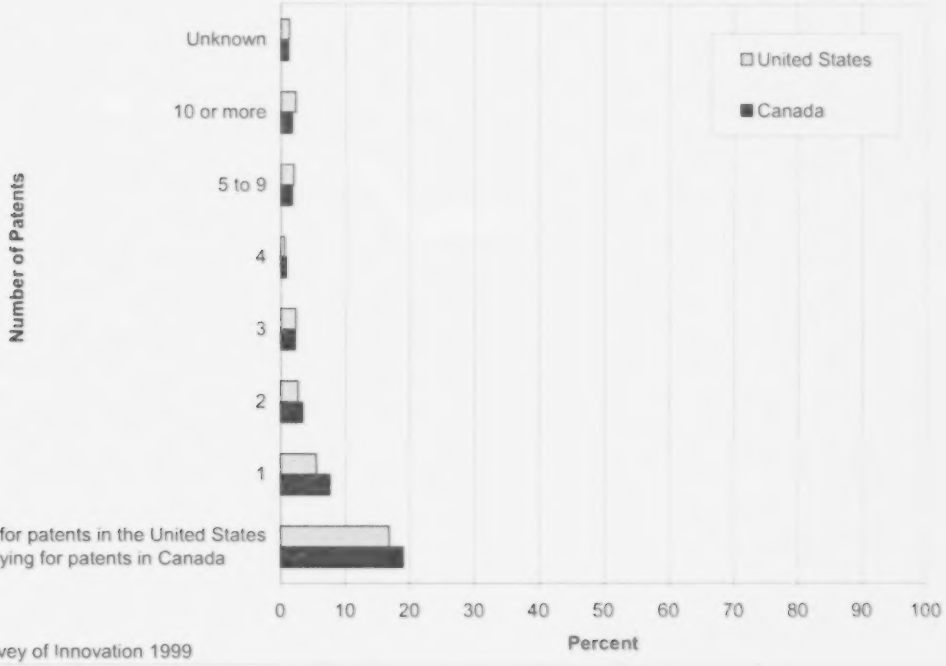
Source: Survey of Innovation 1999

Less than one quarter (22%) of innovative firms in manufacturing indicated that they had applied for at least one patent during the past three years, 1997-1999. Approximately one fifth of innovative manufacturing firms applied for patents in Canada (19%) with almost the same percentage applied for in the US (17%). Fifteen (15%) of innovative manufacturing firms applied for patents in both Canada and the United States with 4% indicating they applied in Canada only and 2% indicating they applied in the United States only.



Most firms that had applied for patents indicated that they had applied for less than 5. Fourteen percent (14%) of firms applied for less than five patents in Canada with the remaining 5% applying for more than five or an unknown number of patents. Eleven percent (11%) of innovative manufacturing firms applied for less than five patents in the US with the remaining 6% applying for more than five or an unknown number of patents.

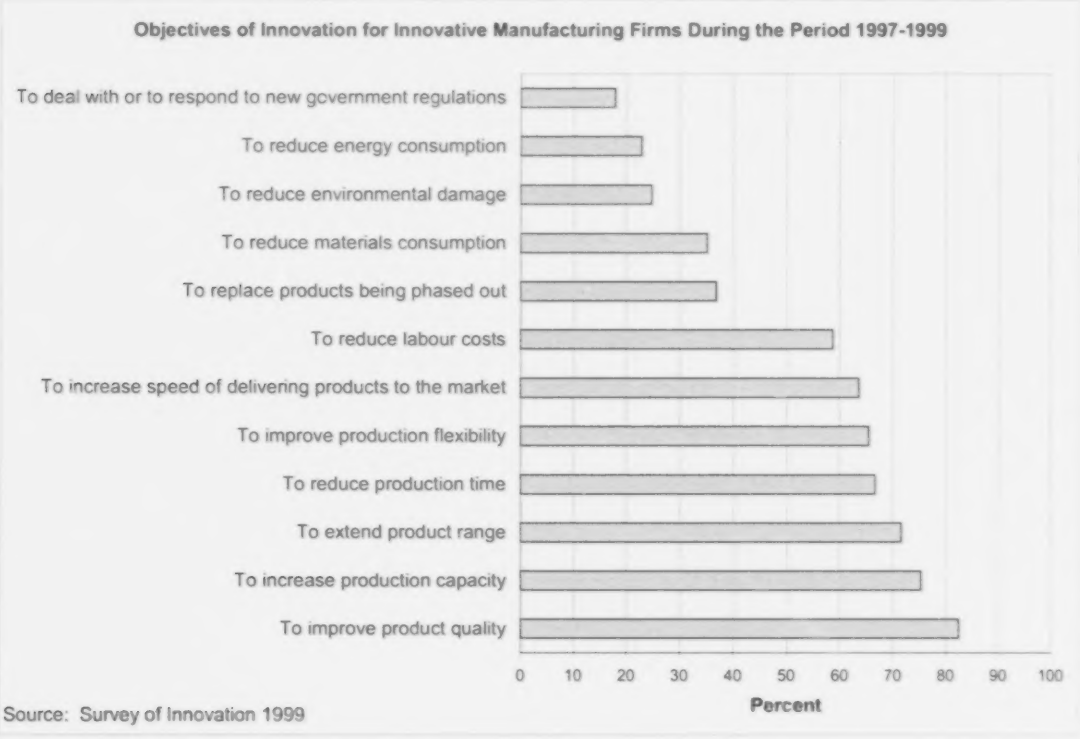
Percent of Innovative Manufacturing Firms with Patent Applications During the Period 1997-1999



Source: Survey of Innovation 1999

9. Objectives of Innovation

The three objectives of innovation most commonly indicated as being important were to improve product quality (83%), to increase production capacity (75%), and to extend product range (72%).

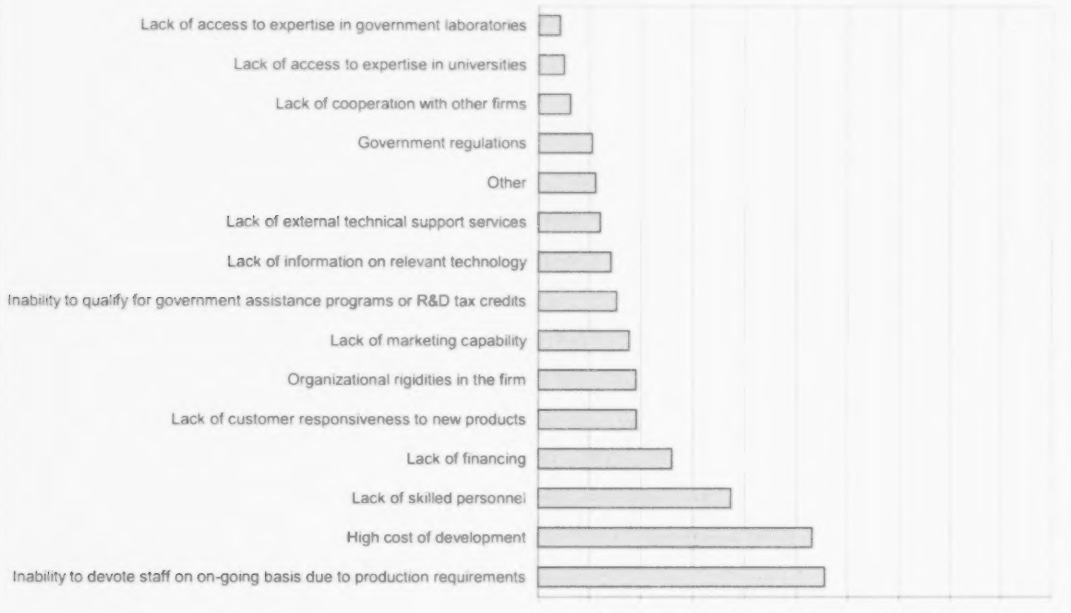


Source: Survey of Innovation 1999

10. Problems and Obstacles Faced by Innovative Manufacturing Firms

Most innovative manufacturing firms (91%) faced problems or obstacles that slowed down or caused problems when they developed new or significantly improved products or introduced new or significantly improved processes. The problems or obstacles most frequently indicated by innovative firms are the inability to devote staff to projects on an on-going basis because of production requirements (56%), the high cost of development (53%), the lack of skilled personnel (37%) and the lack of financing (26%).

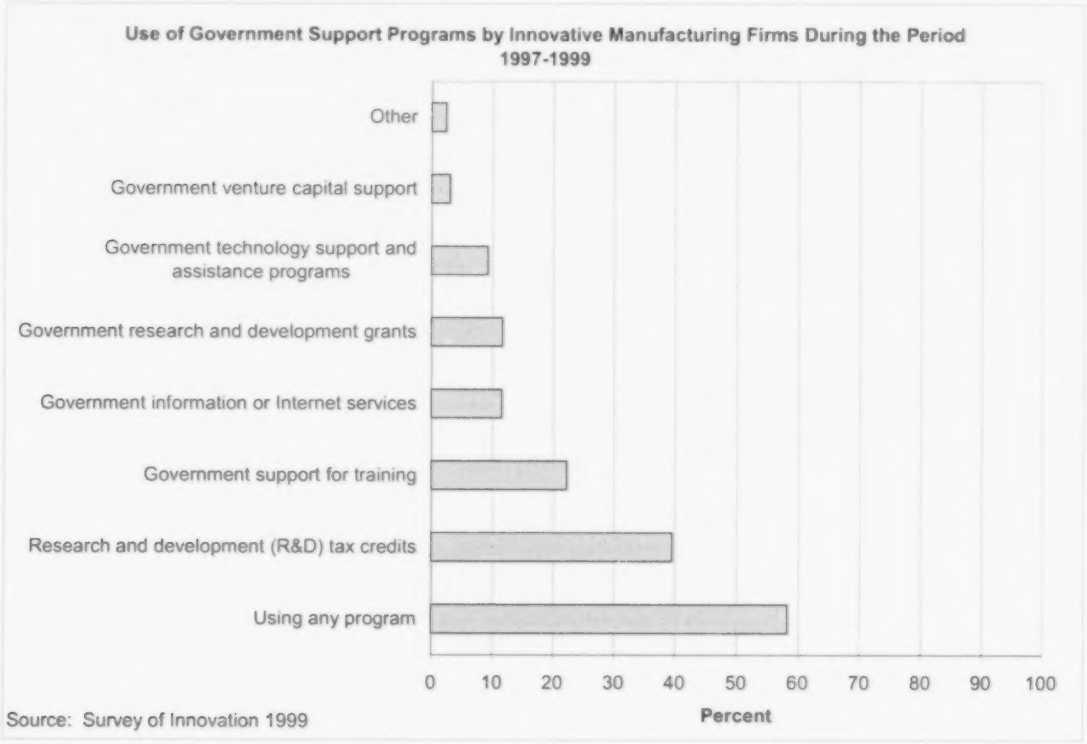
Problems and Obstacles That Manufacturing Firms Faced When They Innovated During the Period 1997-1999



Source: Survey of Innovation 1999

11. Government Support Programs

Over half (58.3%) of innovative manufacturing firms indicated that they used a government support program during the period 1997-1999. R&D tax credits were indicated by 39.6% of innovative firms with 22.3% of firms indicating government support for training as the second most commonly used program.

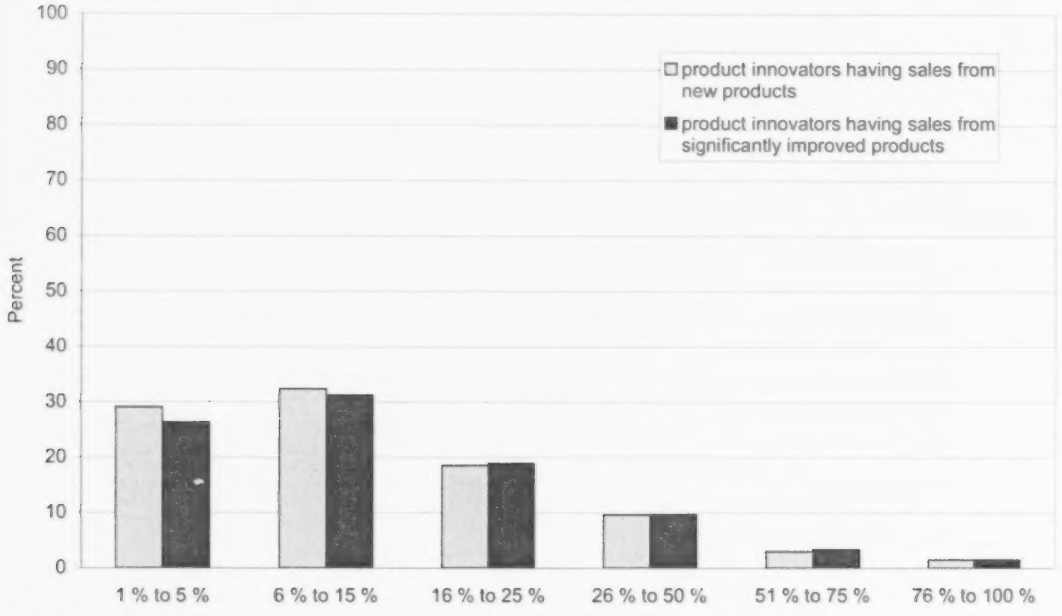


Source: Survey of Innovation 1999

12. Impact of Innovation

Approximately the same percentage of product innovators in manufacturing had sales from new products (94%) or significantly improved products (91%). Most (95%) of the product innovators who attributed sales from new products fell in the range of 1% to 50% of sales. Similarly, most (95%) of the product innovators who attributed sales from significantly improved products fell in the range of 1% to 50% of sales.

Percent of Sales in 1999 for Product Innovators Having Sales from New or Significantly Improved Products Developed During the Period 1997-1999



Source: Survey of Innovation 1999

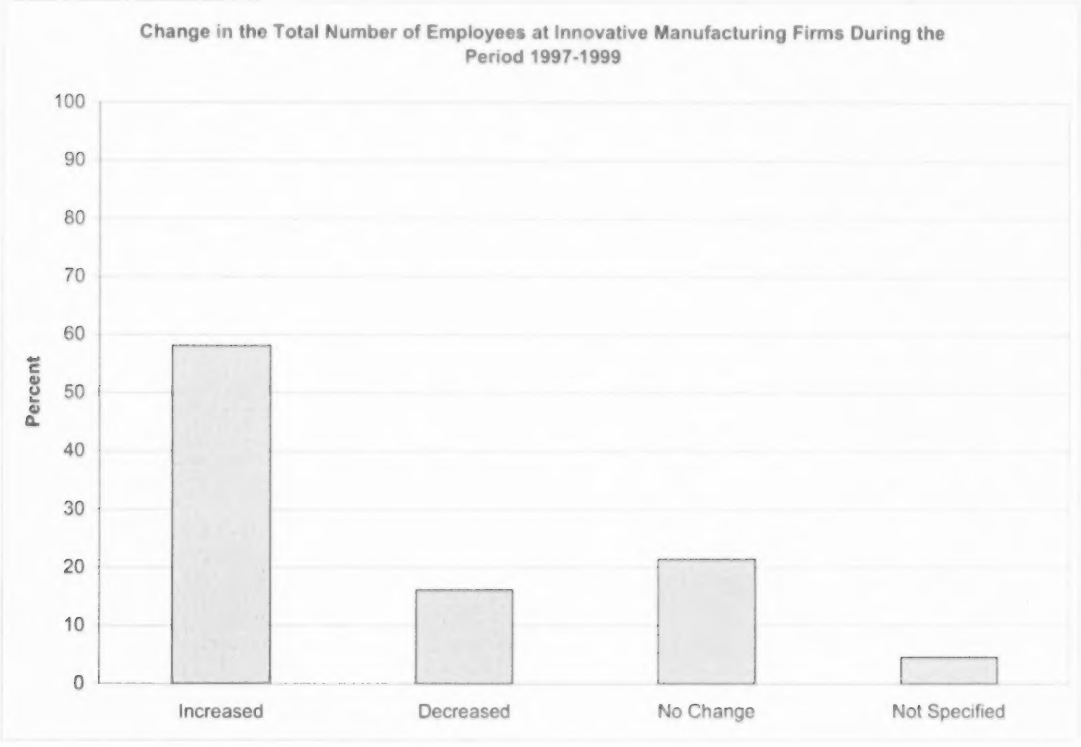
When innovative manufacturing firms were asked to indicate their agreement[3] to a list of important impacts of the new and significantly improved products and processes, over three-quarters (77%) agreed that it allowed the firm to keep up with competitors. The next most agreed upon impact was that it increased the firm's ability to adapt flexibly to different client demands (63%). Fifty-nine percent (59%) of innovative firms agreed that it allowed the firm to maintain profit margins while fifty-seven percent (57%) agreed that it increased the productivity of the firm.

Impact of Innovation on Manufacturing Firms During the Period 1997-1999
increased the firm's international market share
Increased the speed of supplying and/or delivering products (goods or services)
Increased the firm's domestic market share
Increased the productivity of the firm
Increased the profitability of the firm
Allowed the firm to maintain profit margins
Increased the firm's ability to adapt flexibly to different client demands
Allowed the firm to keep up with competitors
0 10 20 30 40 50 60 70 80 90 100
Percent
Source: Survey of Innovation 1999

[3] Respondents responded using a scale from 1 to 5, where 1 is strongly disagree and 5 is strongly agree. "Agreeing" indicates a response of 4 or 5.

13. Human resources

Over half (58%) of the innovative manufacturing firms indicated that their total number of employees had increased during the last three years, 1997-1999. Only sixteen percent (16%) indicated that their total number of employees had decreased and twenty-one percent (21%) reported no change.



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Annex 1: Manufacturing Industry Stratification

The following table contains the industry strata that were used in the sample selection process and the population and sample size. Industries are based on the 1997 North American Industry Classification System (NAICS) codes.

Stratum Number	NAICS		Description	Population	Sample
7	311		Food Manufacturing	856	562
8	312		Beverage and Tobacco Product Manufacturing	99	92
9	313		Textile Mills	174	139
10	314		Textile Product Mills	139	90
11	315		Clothing Manufacturing	571	364
12	316		Leather and Allied Product Manufacturing	80	58
	321		Wood Product Manufacturing		
13		3211	Sawmills and Wood Preservation	290	240
14		3212	Veneer, Plywood and Engineered Wood Product Manufacturing	117	100
15		3219	Other Wood Product Manufacturing	305	204
16	322		Paper Manufacturing	299	253
17	323		Printing and Related Support Activities	598	275
18	324		Petroleum and Coal Products Manufacturing	57	56
	325		Chemical Manufacturing		
19		3251 + 3252 + 3253 + 3255 + 3256 + 3259	Basic Chemical Manufacturing + Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing + Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing + Paint, Coating and Adhesive Manufacturing + Soap, Cleaning Compound and Toilet Preparation Manufacturing + Other Chemical Product Manufacturing	418	324
20		3254	Pharmaceutical and Medicine Manufacturing	62	57
21	326		Plastics and Rubber Products Manufacturing	566	371
22	327		Non-Metallic Mineral Products Manufacturing	378	276
23	331		Primary Metal Manufacturing	227	190
24	332		Fabricated Metal Product Manufacturing	1261	542
	333		Machinery Manufacturing		
25		3331 + 3332	Agricultural, Construction and Mining Machinery Manufacturing + Industrial Machinery Manufacturing	244	196
26		3333 + 3334 + 3335 + 3336 + 3339	Commercial and Service Industry Machinery Manufacturing + Ventilation, Heating, Air-Conditioning and Commercial Refrigeration Equipment Manufacturing + Metalworking Machinery Manufacturing + Engine, Turbine, and Power Transmission Equipment Manufacturing + Other General Purpose Machinery Manufacturing	631	319
	334		Computer and Electronic Product Manufacturing		
27		3341	Computer and Peripheral Equipment Manufacturing	46	39
28		3342	Communications Equipment Manufacturing	68	60
29		3343	Audio and Video Equipment Manufacturing	6	6
30		3344	Semiconductor and other Electronic Equipment Manufacturing	52	46
31		3345 + 3346	Navigational, Measuring, Medical and Control Instruments Manufacturing + Manufacturing and Reproducing Magnetic and Optical Equipment	135	107
32	335		Electrical Equipment, Appliance and Component Manufacturing	222	167
	336		Transportation Equipment Manufacturing		
33		3361+3362 + 3363	Motor Vehicle Manufacturing + Motor Vehicle Body and Trailer Manufacturing + Motor Vehicle Parts Manufacturing	324	209
34		3364	Aerospace Product and Parts Manufacturing	72	57
35		3365 + 3366 + 3369	Railroad Rolling Stock Manufacturing + Ship and Boat Building + Other Transportation Equipment	80	58
36	337		Furniture and Related Product Manufacturing	500	275
37	339		Miscellaneous Manufacturing	426	212
	Total Manufacturing Industries			9303	5944

Annex 2: Tables

All data presented in the following tables are weighted. The reliabilities for all estimates are very good (code A) [4] unless otherwise indicated. The reference period for all data is 1997-1999.

Table 1
Percent of Innovative Firms
All Manufacturing

	Percent
Innovators	80.2
Product Innovators	68.0
Process Innovators	65.8
Both Product and Process Innovators	53.5
Only Product Innovators	14.4
Only Process Innovators	12.3

Source: Survey of Innovation 1999

Table 2
Most Important New or Significantly Improved Product or Process
Innovators in Manufacturing

	Innovators	Both Product and Process Innovators	Only Product Innovators	Only Process Innovators
Described the most important innovation	88.3	90.2	83.2	86.3
Of these, % that reported it was:				
A world first	12.0	12.9	15.2	4.3
A first in Canada (including world first)	32.3	36.1	33.0	14.0

Source: Survey of Innovation 1999

[4] For reliability assessment convention, see Section 1, The Survey and the subsection titled Sampling Error (page 18).

Table 3
Percent of Innovators in Manufacturing Using Listed Sources of Information

	Percent
Firms that used a source of information	96.1
Of these, % that used the following:	
Internal sources of information	
Research and development (R&D) staff	53.4
Marketing staff	66.4
Production staff	72.5
Management staff	76.9
Other internal source	14.7
External sources of information	
Related firms in your corporate group (e.g. parent or subsidiary)	35.9
Suppliers of equipment, material and components	65.4
Clients	65.4
Competitors	36.3
Consultancy firms	19.2
Universities and colleges	8.5
Federal government agencies and research laboratories (e.g. National Research Council of Canada)	8.7
Provincial agencies and research laboratories	5.6
Generally available sources of information	
Trade fairs and exhibitions	68.9
Internet or computer based information networks	38.2
Professional conferences, meetings and publications	51.1
Other sources of information	8.7

Source: Survey of Innovation 1999

Table 4
Percentage of Firms Engaged In Activities Linked To Product or Process Innovation Innovators in Manufacturing

	Percent
Acquisition of Process Equipment	85.5
Training	81.3
Research and Development	76.9
Tooling Up and Production Start-up	70.8
Industrial Design + Engineering	64.7

Source: Survey of Innovation 1999

Table 5
Research and Development
Innovators in Manufacturing

	Percent
Firms who undertook R&D activities	67.5
Of these, % for whom R&D is:	
Carried out by a separate and distinct R&D department	45.2
Contracted out to other firms	28.5
Both carried out by a separate and distinct R&D department and contracted out to other firms	15.6
Only carried out by a separate and distinct R&D department	29.6
Only contracted out to other firms	12.9
Neither carried out by a separate and distinct R&D department nor contracted out to other firms	41.9

Source: Survey of Innovation 1999

Table 6
Cooperative and Collaborative Arrangements
Innovators in Manufacturing

	Percent
% Having Cooperative or Collaborative Arrangements	33.0
Reasons for Having Arrangements	
Accessing critical expertise	55.1
Accessing research and development (R&D)	52.2
Prototype development	47.9
Accessing new markets	44.5
Sharing costs	41.5
Spreading risk	26.8
Accessing new distribution channels	25.6
Scaling-up production processes	24.3
Other	6.0

Source: Survey of Innovation 1999

Table 7
Methods Used to Protect Intellectual Property
Innovators in Manufacturing

	Percent
Firms that protected intellectual property	72.6
Of these, % that used:	
Patents	40.3
Trademarks	54.8
Copyrights	18.8
Confidentiality agreements	66.7
Trade secrets	39.1
Other	3.7

Source: Survey of Innovation 1999

Table 8
Application for Patents in Canada and the United States
Innovators in Manufacturing

	Percent
Applied For At Least One Patent	22.4
Of These, % That Applied For Patents In:	
Canada	85.2
United States	75.4
Both Canada and the United States	65.8
Canada Only	19.5
United States Only	9.6
Neither Canada nor the United States	5.1

Source: Survey of Innovation 1999

Table 9
Objectives of Innovation
Innovators in Manufacturing

	Relevant	Importance				
		Low	Moderately Low	Medium	Moderately High	High
Productivity						
To reduce labour costs	93.7	9.9	9.6	17.9	25.4	37.3
To increase production capacity	95.6	4.2	6.0	11.0	29.3	49.5
To reduce production time	93.7	6.1	7.3	15.4	30.1	41.1
To improve production flexibility	94.3	4.6	7.6	18.3	32.9	36.6
Product						
To extend product range	94.0	3.4	5.3	15.2	29.4	46.8
To improve product quality	96.3	1.4	2.7	10.2	31.6	54.1
To increase speed of delivering products to the market	93.6	5.6	7.9	18.5	25.6	42.4
To replace products being phased out	82.8	16.8	16.7	22.0	21.6	23.0
Other						
To reduce materials consumption	82.5	18.3	17.3	21.7	21.5	21.2
To reduce environmental damage	74.7	24.8	19.5	22.5	17.2	16.0
To reduce energy consumption	79.9	24.3	21.4	25.6	16.7	12.0
To deal with or to respond to new government regulations	71.0	31.3	20.6	23.0	13.1	12.1

Source: Survey of Innovation 1999

Table 10
Problems and Obstacles That Firms Faced When They Innovated
Innovators in Manufacturing

	Percent
Firms that faced problems and obstacles	90.6
Of these, % that faced the following:	
High cost of development	58.7
Inability to devote staff to projects on an on-going basis because of production requirements	61.4
Inability to qualify for government assistance programs or research and development (R&D) tax credits	16.9
Lack of skilled personnel	41.3
Lack of financing	28.8
Lack of marketing capability	19.6
Lack of information on relevant technology	15.7
Lack of external technical support services	13.4
Lack of access to expertise in universities	5.6
Lack of access to expertise in government laboratories	4.7
Lack of cooperation with other firms	6.9
Lack of customer responsiveness to new products	21.2
Organizational rigidities in the firm	21.1
Government regulations	11.6
Other	12.4

Source: Survey of Innovation 1999

Table 11
Use of Government Support Programs
Innovators in Manufacturing

	% Using a Program	Of These, % Using Programs Sponsored By:				
		Federal Government	Provincial Governments	Both Federal and Provincial Governments	Federal Government Only	Provincial Governments Only
% using any program	58.3	82.2	73.0	55.3	27.0	17.8
Of these, % using the following programs:						
Research and development (R&D) tax credits	67.9	94.3	62.0	56.3	38.0	5.7
Government research and development grants	20.1	79.4	43.1	22.5	56.9	20.6
Government venture capital support	5.3	42.4*	71.4	13.7	28.6	57.6*
Government technology support and assistance programs	16.0	56.9	61.6	18.5	38.4	43.1
Government information or Internet services	19.9	81.0	62.5	43.5	37.5	19.0
Government support for training	38.3	38.4	80.2	18.6	19.8	61.6
Other	4.1	62.2*	52.0*	14.1*	48.0*	37.8*

Source: Survey of Innovation 1999

Table 12
Impact on Sales in 1999 of Significantly Improved Products (Goods or Services)
Innovators in Manufacturing

		Percentage of Sales					
		1 % to 5 %	6 % to 15 %	16 % to 25 %	26 % to 50 %	51 % to 75 %	76 % to 100 %
Product Innovators	84.7						
Of These, % Having Sales From New Products	93.9	30.9	34.4	19.7	10.2	3.1	1.5
Of These, % Having Sales From Significantly Improved Products	90.6	29.0	34.4	20.8	10.6	3.6	1.6

Source: Survey of Innovation 1999

* B rating code for reliability

Table 13
Impact of Innovation on Firm
Innovators in Manufacturing

	Relevant	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Increased the productivity of the firm	94.1	5.3	9.9	25.3	36.6	22.9
Increased the profitability of the firm	97.3	3.7	8.8	29.1	36.7	21.7
Increased the speed of supplying and/or delivering products (goods or services)	91.1	7.3	16.1	28.5	30.8	17.3
Increased the firm's ability to adapt flexibly to different client demands	94.1	1.9	7.5	23.2	43.2	24.2
Increased the firm's domestic market share	93.0	7.0	14.0	30.4	32.5	16.1
Increased the firm's international market share	80.4	13.9	15.2	23.6	29.9	17.4
Allowed the firm to maintain profit margins	96.0	2.7	7.9	28.1	39.0	22.2
Allowed the firm to keep up with competitors	96.4	1.4	3.6	15.6	44.3	35.2

Source: Survey of Innovation 1999

Table 14
Change in the Total Number of Employees
Innovators in Manufacturing

	Percent
Increased	58.1
Decreased	16.1
No Change	21.4
Not Specified	4.5

Source: Survey of Innovation 1999

Annex 3: Questionnaire

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Science, Innovation and Electronic Information Division

Survey of Innovation 1999

Si vous préférez recevoir ce questionnaire en français, ☐ veuillez cocher

Confidential when completed

Correct pre-printed information if necessary using the corresponding boxes provided below.

Legal Name	
Business Name	
C / O	
No. & Street	
City	
Province	Postal Code
Contact	
Téléphone no. Area code	Extension
Facsimile no. Area code	

Survey Purpose

The information you provide is essential to assure the availability of pertinent information on innovation. The information compiled from the survey can be used by firms for market analysis, by trade associations to study performance and other characteristics of their industries, and by government to develop national and regional economic policies.

Authority

This survey is conducted under the authority of the Statistics Act, Revised Statutes of Canada, Chapter S19. Completion of this questionnaire is a legal requirement under the Statistics Act.

Confidentiality

Statistics Canada is prohibited by law from publishing any statistics which would divulge information obtained from this survey that relates to any identifiable firm without the previous consent of that firm. The data reported in this questionnaire will be treated in strict confidence, used for statistical purposes and published in aggregate form only. Statistics Canada will create a data base combining individual survey responses with existing Statistics Canada data records. The confidentiality provisions of the Statistics Act are not affected by either the Access to Information Act or any other legislation.

Federal-Provincial Agreement

In order to avoid duplication of enquiry, to reduce the cost of collection and to provide consistent statistics, an agreement has been made with the Bureau de la Statistique du Québec, under Section 11 of the Statistics Act, Statutes of Canada, where data on firms located or operating in Québec will be transmitted to the Bureau de la Statistique du Québec. The Statistics Act of Québec includes the same provisions for confidentiality and penalties for disclosure of information as the Federal Statistics Act.

In this questionnaire, "**firm**" refers to the legal entity that owns your plant or establishment which operates in Canada.

5-4900-497.1: 1999-07-21 STC/SAT-465-05484

Statistics Canada Statistique Canada

Canada

Competitive Environment

1. For your firm, how strongly do you agree or disagree with each of the following statements?

Please indicate your opinion by using the following scale where 1 is strongly disagree and 5 is strongly agree. Check 0 if not relevant to your firm.

	Strongly Disagree 1	2	3	4	Strongly agree 5	Not Relevant 0
a. My client's demands are easy to predict	○	○	○	○	○	○
b. My clients can easily substitute my products (goods or services) for the products of my competitors	○	○	○	○	○	○
c. My competitors' actions are easy to predict	○	○	○	○	○	○
d. The arrival of new competitors is a constant threat	○	○	○	○	○	○
e. The arrival of competing products (goods or services) is a constant threat	○	○	○	○	○	○
f. My firm can easily replace its current suppliers	○	○	○	○	○	○
g. It is difficult to hire qualified staff and workers	○	○	○	○	○	○
h. It is difficult to retain qualified staff and workers	○	○	○	○	○	○
i. My products (goods or services) quickly become obsolete	○	○	○	○	○	○
j. Production technologies change rapidly	○	○	○	○	○	○
k. Office technologies change rapidly	○	○	○	○	○	○

Firm Success Factors

2. Please rate the importance of each of the following factors for the success of your firm.

Please indicate your opinion by using the following scale where 1 is low importance and 5 is high importance. Check 0 if not relevant to your firm.

	Importance					
	Low				High	Not Relevant
	1	2	3	4	5	0
Markets and Products						
a. Seeking new markets	○	○	○	○	○	○
b. Satisfying existing clients	○	○	○	○	○	○
c. Developing niche or specialized markets	○	○	○	○	○	○
d. Developing export markets	○	○	○	○	○	○
e. Promoting firm or product (good or service) reputation	○	○	○	○	○	○
f. Providing after-hour client support services	○	○	○	○	○	○
Human Resources						
g. Hiring new graduates from universities	○	○	○	○	○	○
h. Hiring new graduates from technical schools and colleges	○	○	○	○	○	○
i. Hiring experienced employees	○	○	○	○	○	○
j. Recruiting skilled people from outside of Canada	○	○	○	○	○	○
k. Training employees	○	○	○	○	○	○
l. Using teams within your firm which bring together people with different skills	○	○	○	○	○	○
Other						
m. Performing research and development within your firm	○	○	○	○	○	○
n. Involvement in collaboration and cooperation with other firms	○	○	○	○	○	○
o. Developing new products (goods or services) and processes	○	○	○	○	○	○
p. Active involvement in developing new industry-wide standards	○	○	○	○	○	○

New and Significantly Improved Products and Processes

3. A **new product (good or service)** is a product which is new to your firm whose characteristics or intended uses differ significantly from those of your firm's previously produced products.

   A **significantly improved product (good or service)** is an existing product whose performance has been significantly enhanced or upgraded. A complex product which consists of a number of components or integrated subsystems may be improved by partial changes to one of the components or subsystems. Changes to your firm's existing products which are purely aesthetic or which only involve minor modifications are not to be included.

   During the last three years, 1997 to 1999, did your firm offer new or significantly improved **products (goods or services)** to your clients?

   [1] ○ Yes ↓ [3] ○ No → *Go to Question 4*

   If yes, please indicate how many new or significantly improved products were offered in the **last three years, 1997 to 1999**?

   Please check the appropriate number.

   [1] ○ 1-2
   [2] ○ 3-5
   [3] ○ 6-10
   [4] ○ 11-20
   [5] ○ 21-50
   [6] ○ More than 50

---

4. **New production/manufacturing processes are processes** which are new to your firm. They involve the introduction into your firm of new production/manufacturing methods, procedures, systems, machinery or equipment which differs significantly from your firm's previous production/manufacturing processes.

   Significantly improved production/manufacturing processes involve significant changes to your existing processes which may be intended to produce new or significantly improved products (goods or services) or production/manufacturing processes. Minor or routine changes to processes are not to be included.

   During the last three years, 1997 to 1999, did your firm introduce **new or significantly improved production/manufacturing processes**?

   [1] ○ Yes [3] ○ No

---

5. **During the last three years, 1997 to 1999**, did your firm have any unsuccessful or not yet completed projects to develop or introduce new or significantly improved products (goods or services) or production/manufacturing processes?

   [1] ○ Yes [3] ○ No

6. **During the last three years, 1997 to 1999**, did your firm engage in the following activities which are linked to offering new or significantly improved products (goods or services) or to introducing new or significantly improved production/manufacturing processes?

	Yes	No
a. Research and development (R&D) linked to new or significantly improved products (goods or services) or production/manufacturing processes	1 ◯	3 ◯
b. Acquisition of machinery, equipment or other technology linked to new or significantly improved products (goods or services) or production/manufacturing processes	1 ◯	3 ◯
c. Industrial engineering and industrial design linked to new or significantly improved products (goods or services) or production/manufacturing processes	1 ◯	3 ◯
d. Tooling up and production start-up linked to new or significantly improved products (goods or services) or production/manufacturing processes	1 ◯	3 ◯
e. Training linked to the introduction of new or significantly improved products (goods or services) or production/manufacturing processes	1 ◯	3 ◯

If all answers to Questions 3 to 6 are "no", please proceed to Question 7.

If at least one answer to Questions 3 to 6 is "yes", please proceed to Question 8.

7. Why did your firm **not** develop or introduce new or significantly improved products (goods or services) or production/manufacturing processes **during the last three years, 1997 to 1999**?

_____

_____

_____

_____

Please proceed to Question 21.

Sources of Information

8. Which of the following played an **important role** as sources of information needed for suggesting or contributing to the development of new or significantly improved products (goods or services) or production/manufacturing processes, **during the last three years, 1997 to 1999**?

Please check all that apply.

INTERNAL sources of information to your firm:

1 ◯ Research and development (R&D) staff
2 ◯ Marketing staff
3 ◯ Production staff
4 ◯ Management staff
5 ◯ Other (*please specify*): _____

_____

Conclusion

8. Which of the following played an **important role** as sources of information needed for suggesting or contributing to the development of new or significantly improved products (goods or services) or production/manufacturing processes, **during the last three years, 1997 to 1999**.

Please check all that apply.

EXTERNAL sources of information to your firm:

- 6 ◯ Related firms in your corporate group (e.g. parent or subsidiary)
- 7 ◯ Suppliers of equipment, material and components
- 8 ◯ Clients
- 9 ◯ Competitors
- 10 ◯ Consultancy firms
- 11 ◯ Universities and colleges
- 12 ◯ Federal government agencies and research laboratories (e.g. National Research Council of Canada)
- 13 ◯ Provincial agencies and research laboratories

Generally available sources of information

- 14 ◯ Trade fairs and exhibitions
- 15 ◯ Internet or computer based information networks
- 16 ◯ Professional conferences, meetings and publications

Other sources of information

- 17 ◯ *Please specify:* _____
- 18 ◯ None of the above

Objectives

9. Please indicate the main reasons why your firm offered new or significantly improved products (goods or services) or introduced new or significantly improved production/manufacturing processes **during the last three years, 1997 to 1999**.

Please indicate the degree of importance attached to each objective by using the following scale where 1 is low importance and 5 is high importance. Check 0 if not relevant to your firm.

	Low / Importance / High					Not Relevant
	1	2	3	4	5	0
Productivity						
a. To reduce your labour costs	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
b. To increase production capacity	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
c. To reduce production time	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
d. To improve production flexibility	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
Product						
e. To extend product range	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
f. To improve product quality	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
g. To increase speed of delivering products to the market	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
h. To replace products being phased out	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯

Conclusion

9. Please indicate the main reasons why your firm offered new or significantly improved products (goods or services) or introduced new or significantly improved production/manufacturing processes **during the last three years, 1997 to 1999**.

Please indicate the degree of importance attached to each objective by using the following scale where 1 is low importance and 5 is high importance. Check 0 if not relevant to your firm.

	Importance					
	Low				High	Not Relevant
	1	2	3	4	5	0
Other						
i. To reduce materials consumption	1 ○	2 ○	3 ○	4 ○	5 ○	0 ○
j. To reduce environmental damage	1 ○	2 ○	3 ○	4 ○	5 ○	0 ○
k. To reduce energy consumption	1 ○	2 ○	3 ○	4 ○	5 ○	0 ○
l. To deal with or to respond to new government regulations	1 ○	2 ○	3 ○	4 ○	5 ○	0 ○

Problems and Obstacles

10. Which of the following slowed down or caused problems for your firm when it developed new or significantly improved products (goods or services) or introduced new or significantly improved production/manufacturing processes **during the last three years, 1997 to 1999**?

Please check all that apply.

1 ○ High cost of developing new or significantly improved products or processes

2 ○ Inability to devote staff to projects to develop new or significantly improved products or processes on an on-going basis because of production requirements

3 ○ Inability to qualify for government assistance programs or research and development (R&D) tax credits

4 ○ Lack of skilled personnel to develop or introduce new or significantly improved products or processess

5 ○ Lack of financing for the development or introduction of new or significantly improved products or processes

6 ○ Lack of marketing capability to market new or significantly improved products

7 ○ Lack of information on technology relevant to the development or introduction of new or significantly improved products or processes

8 ○ Lack of external technical support services required to develop or introduce new or significantly improved products or processes

9 ○ Lack of access to expertise in universities that could assist in developing or introducing new or significantly improved products or processes

10 ○ Lack of access to expertise in government laboratories that could assist in developing or introducing new or significantly improved products and/or processes

11 ○ Lack of cooperation with other firms

Conclusion

10. Which of the following slowed down or caused problems for your firm when it developed new or significantly improved products (goods or services) or introduced new or significantly improved production/manufacturing processes **during the last three years, 1997 to 1999**?

Please check all that apply.

12 ◯ Lack of customer responsiveness to new products

13 ◯ Organizational rigidities in your firm which prevent the development or introduction of new or significantly improved products or processes

14 ◯ Government regulations affecting new or significantly improved products or processes

15 ◯ Other *(please specify)*:

_____

_____

_____

_____

11. Please provide a concrete example of the most significant problem or obstacle your firm encountered when developing new or significantly improved products (goods or services) or production/manufacturing processes **during the last three years, 1997 to 1999**.

_____

_____

_____

_____

_____

Impact

12. Did your firm introduce any new or significantly improved products **during the last three years, 1997 to 1999**?

1 ◯ Yes ↓ 3 ◯ No → *Go to Question 13*

If yes, please estimate the percentage of your sales in 1999 (to date) that resulted from new or significantly improved products (goods or services) introduced by your firm **during the last three years, 1997 to 1999**. Please refer to definitions of new and significantly improved products (goods or services) in Question 3.

Please check the appropriate circles.

	1 % to 5 %	6 % to 15 %	16 % to 25 %	26 % to 50 %	51 % to 75 %	76 % to 100 %
Sales in 1999 from new products (goods or services) introduced between 1997 and 1999	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	6 ◯
Sales in 1999 from significantly improved products (goods or services) introduced between 1997 and 1999	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	6 ◯

13. What impact did new and significantly improved products (goods or services) and new significantly improved production/manufacturing processes developed and introduced **during the last three years, 1997 to 1999** have on your firm?

Please indicate your opinion by using the following scale where 1 is strongly disagree and 5 is strongly agree. Check 0 if not relevant to your firm.

	Strongly Disagree 1	2	3	4	Strongly Agree 5	Not Relevant 0
a. Increased the productivity of your firm	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
b. Increased the profitability of your firm	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
c. Increased the speed of supplying and/or delivering your products (goods or services)	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
d. Increased your firm's ability to adapt flexibly to different client demands	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
e. Increased your firm's domestic market share	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
f. Increased your firm's international market share	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
g. Allowed your firm to maintain its profit margins	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯
h. Allowed your firm to keep up with its competitors	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	0 ◯

Cooperative and Collaborative Arrangements

14. **Cooperative and collaborative arrangement**s involve the active participation in joint projects between your firm and other firms or organizations in order to develop new or significantly improved products (goods or services) and/or production/manufacturing processes. Pure contracting-out work, where there is no active participation, is not regarded as collaboration or cooperation.

Was your firm involved in cooperative and collaborative arrangements with other firms or organizations to develop new or significantly improved products (goods or services) or production/manufacturing processes **during the last three years, 1997 to 1999**?

1 ◯ Yes ↓ 3 ◯ No → *Go to Question 17*

If yes, please indicate which of the following reasons are important in determining the involvement of your firm in cooperative and collaborative arrangements to develop new or significantly improved products (goods or services) and/or production/manufacturing processes **during the last three years, 1997 to 1999**?

1 ◯ Sharing costs
2 ◯ Spreading risk
3 ◯ Accessing research and development R&D
4 ◯ Prototype development
5 ◯ Scaling-up production processes
6 ◯ Accessing critical expertise
7 ◯ Accessing new markets
8 ◯ Accessing new distribution channels
9 ◯ Other *(please specify)*: _____

15. If your firm has **more than one Canadian location**, please proceed to **Question 16**.

If your firm has **only one Canadian location**, please indicate the location of other firms and organizations with which your firm had cooperative and collaborative arrangements to develop new or significantly improved products (goods or services) and production/manufacturing processes **during the last three years, 1997 to 1999**.

Please check the appropriate circles.	Within 100 km	In the rest of your province	In the rest of Canada	US	Europe	Pacific Rim	Other
a. Competitors	1	2	3	4	5	6	7
b. Clients	1	2	3	4	5	6	7
c. Consulting firms	1	2	3	4	5	6	7
d. Suppliers	1	2	3	4	5	6	7
e. Federal government research institutes (e.g. National Research Council of Canada)	1	2	3	4	5	6	7
f. Provincial government research institutes	1	2	3	4	5	6	7
g. Universities	1	2	3	4	5	6	7
h. Other	1	2	3	4	5	6	7

↓
Please specify: _____

Please proceed to Question 17.

16. If your firm has **more than one Canadian location**, please check the location of other firms and organizations with which your firm had cooperative and collaborative arrangements to develop new or significantly improved products (goods or services) and production/manufacturing processes **during the last three years, 1997 to 1999**.

Please check the appropriate circles.	Canada	US	Europe	Pacific Rim	Other
a. Competitors	1	2	3	4	5
b. Clients	1	2	3	4	5
c. Consulting firms	1	2	3	4	5
d. Suppliers	1	2	3	4	5
e. Federal government institutes (e.g. National Research Council of Canada)	1	2	3	4	5
f. Provincial government research institutes	1	2	3	4	5
g. Other firms within your corporate group (e.g. parent or subsidiary)	1	2	3	4	5
h. Universities	1	2	3	4	5
i. Other	1	2	3	4	5

↓
Please specify: _____

The Most Important New or Significantly Improved Product or Process

17. Please provide below a brief description of your **most important** new or significantly improved product (good or service) or production/manufacturing process **during the last three years, 1997 to 1999**.

18. Was this most important new or significantly improved product (good or service) or production/manufacturing process:

	Yes	No	Do not know
a. a world first?	1 ○	3 ○	N ○
b. a first in Canada?	1 ○	3 ○	N ○
c. a first for your firm?	1 ○	3 ○	N ○

19. How long did it take from initial idea generation to the implementation of this most important new or significantly improved product (good or service) or production/manufacturing process?

	years		months

20. Did this most important new or significantly improved product (good or service) or production/manufacturing process involve:

	Yes	No	Do not know
a. The use of new materials?	1 ○	3 ○	N ○
b. An investment in machinery or equipment?	1 ○	3 ○	N ○
c. New software developed by or specifically for your firm?	1 ○	3 ○	N ○

Building and Construction Products

21. **During the last three years, 1997 to 1999**, did your firm offer products which were **incorporated into** buildings and other engineering works such as roads, dams, bridges, sewers, transmission lines and pipelines? Some examples of building products are windows, plaster board, bricks, concrete, heating and plumbing systems, roofing, security systems, electrical systems and others.

1 ○ Yes 2 ○ No → *Please go to Question 22*

↓

If yes, please estimate the percentage of your total sales from these products, **during the last three years, 1997 to 1999**.

Please check the appropriate circle.

1 % to 5 %	6 % to 15 %	16 % to 25 %	26 % to 50 %	51 % to 75 %	76 % to 100 %	Do not know
1 ○	2 ○	3 ○	4 ○	5 ○	6 ○	N ○

22. **During the last three years, 1997 to 1999**, did your firm offer machinery, equipment or tools which were **used during the process** of constructing buildings and other engineering works such as roads, dams, bridges, sewers, transmission lines, and pipelines? Some examples of products used during construction are bulldozers, cranes, power tools, scaffolding, survey equipment and others.

1 ◯ Yes ↓ 3 ◯ No → *Go to Question 23*

If yes, please estimate the percentage of your total sales from these products, **during the last three years, 1997 to 1999**.

Please check the appropriate circle.

1 % to 5 %	6 % to 15 %	16 % to 25 %	26 % to 50 %	51 % to 75 %	76 % to 100 %	Do not know
1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	6 ◯	N ◯

Natural Resource Products

23. Are your products used by natural resource industries?

1 ◯ Yes ↓ 3 ◯ No → *Go to Question 24*

If yes, please estimate the percentage of your total sales of products (goods or services) that were used by the following natural resources industries, **during the last three years, 1997 to 1999**.

Please check the appropriate circles.

	1 % to 5 %	6 % to 15 %	16 % to 25 %	26 % to 50 %	51 % to 75 %	76 % to 100 %	Do not know
a. Mining industry	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	6 ◯	N ◯
b. Logging and forestry industries	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	6 ◯	N ◯
c. Oil and gas extraction industries	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	6 ◯	N ◯
d. Electrical utilities	1 ◯	2 ◯	3 ◯	4 ◯	5 ◯	6 ◯	N ◯

Research and Development, Intellectual Property and Human Resources

24. **During the past three years, 1997 to 1999**, did your firm undertake research and development (R&D) activities?

[1] ◯ Yes ↓ [3] ◯ No → *Go to Question 25*

If yes,

	Yes	No
Is research and development (R&D) carried out in your firm by a separate and distinct research and development (R&D) department?	[1] ◯	[3] ◯
Is research and development (R&D) contracted out to other firms?	[1] ◯	[3] ◯

If yes, please indicate if the research and development (R&D) was performed

↓

[1] ◯ continuously

[2] ◯ occasionally

---

25. Please indicate which of the following methods have been used by your firm to protect its intellectual property **during the past three years, 1997 to 1999**.

	Yes	No
a. Patents	[1] ◯	[3] ◯
b. Trademarks	[1] ◯	[3] ◯
c. Copyrights	[1] ◯	[3] ◯
d. Confidentiality agreementsé	[1] ◯	[3] ◯
e. Trade secrets	[1] ◯	[3] ◯

h. Other (*please specify*): _____

_____

---

26. Did your firm apply for at least one patent **during the last three years, 1997 to 1999**?

[1] ◯ Yes ↓ [3] ◯ No → *Go to Question 27*

If yes, how many patents did your firm apply for **during the last three years, 1997 to 1999**?

Number in Canada ☐☐

Number in United States ☐☐

---

27. How many people does your firm currently employ?

Number of employees ☐☐☐☐

28. **During the last three years, 1997 to 1999**, has the total number of employees in your firm

1 ◯ increased?

2 ◯ decreased?

3 ◯ remained the same?

Government Support Programs

29. Has your firm used any of the following types of programs sponsored by the federal government or a provincial government **during the last three years, 1997 to 1999**?

Please check the appropriate circles.

	Government Programs		Did not use a government program
	Federal Government	Provincial Government	
a. Research and development (R&D) tax credits	1 ◯	2 ◯	3 ◯
b. Government research and development (R&D) grants	1 ◯	2 ◯	3 ◯
c. Government venture capital support	1 ◯	2 ◯	3 ◯
d. Government technology support and assistance programs	1 ◯	2 ◯	3 ◯
e. Government information or Internet services	1 ◯	2 ◯	3 ◯
f. Government support for training	1 ◯	2 ◯	3 ◯

g. Other (*please specify*): _____

_____

Comments

30. In your view, what can be done to improve the ability of Canadian firms to develop new and significantly improved products (goods or services) or production/manufacturing processes?

_____

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